Drought responses in Chardonnay and Sauvignon blanc grapevine cultivars: Mechanistic insights and varietal contrasts

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Abstract (250 words)

This study explored the responses of Chardonnay and Sauvignon blanc grapevine cultivars to water deficit across four years, uncovering their shared patterns and distinctive coping mechanisms. The research was conducted in a commercial vineyard located in Isla de Maipo, Chile. Various characterization approaches were employed including plant water potentials (Ψ), gas exchange measurements, shoot vulnerability curves, productivity assessments, and leaf cell water relations. Linear mixed models and sensitivity analyses were performed using various statistical methods to evaluate cultivar responses to water deficit. As the water deficit progressed, both cultivars displayed a parallel reduction in stomatal conductance, leaf turgor, and increased shoot embolism. Moreover, both cultivars exhibit a sigmoid decrease in yield as Ψ_{leaf} declined, highlighting a 50% productivity reduction corresponding to a 50% reduction in stomatal conductance. However, Chardonnay demonstrated higher drought tolerance, achieving more negative Ψ_{leaf} values during water deficit, with leaf turgor loss occurring at a lower Ψ threshold. Furthermore, differences in Ψ_{leaf} between the cultivars stemmed from their distinct drought-coping mechanisms. Chardonnay employed osmotic adjustment to facilitate water movement and maintain turgor, while Sauvignon blanc relied on elastic adjustment to sustain elevated leaf water content. Sensitivity analysis suggests the limited impact of osmotic adjustment on Chardonnay's Ψ_{leaf} variability, emphasizing its function as a delayed response to water stress. Conversely, Sauvignon blanc's higher bulk elastic modulus influences Ψ_{leaf} fluctuations more prominently, promoting rapid rehydration under water scarcity. These mechanisms determined Ψ_{leaf} magnitudes, with Sauvignon blanc exhibiting lower stress levels than Chardonnay.

Keywords: Grapevine cultivars, water deficit, drought tolerance, osmotic adjustment, bulk elastic modulus.